B I D D I N G D O C U M E N T

for

The Work of Design, Engineering, Construction and Commissioning 10 MLD Sewage Treatment Plantwith Biological Nutrient Removal (BNR) at Anjanapura-2 BDA layoutwith 10 MLD TSPS, Pumping Main and Operation & Maintenance for Seven Years.

(DBO contract)

Contract Package –
BWSSB - ANJ-2 - BDA

National Competitive Bidding (NCB)

EMPLOYER'S REQUIREMENT

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PART 5

PROCESSREQUIREMENT

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PART 5

PROCESS REQUIREMENT

5.0 PROCESS REQUIREMENT

Process, hydraulic and other plant design requirements for the TSPS and STPof this Contract are described herein Part 5 – "Process Requirement".

5.1 Sewage Treatment Plants and Terminal Sewage Pumping Station

Following table shows the design average flow capacity for STP with TSPS.

S.No.	Name	Capacity (MLD)
1	Anjanapura -2	10MLD STP with 10 MLD TSPS

STP shall be designed and constructed for the flows and pollution loadsas specified withtreatment process as follows:

- **Sequencing Batch Reactor (SBR) with Biological Nutrient Removal (Nitrification, De-nitrification, and Phosphorus Removal), with Tertiary Treatment, Chlorine Disinfection and Sludge Dewatering.**

5.2 Influent Wastewater Characteristics

The influent wastewater characteristics to be used as the basis of design are listed in Paragraph5.16– "TSPS & STP Design/Sizing Criteria and Other Requirements".

5.3 Effluent Quality Requirements

The treated effluent quality requirements to be met are listed in Paragraph 5.16–"TSPS & STP Design/Sizing Criteria and Other Requirements".

5.4 Dewatered Sludge Quality Requirements

The dewatered sludge quality requirements to be met are listed in Paragraph 5.16–"TSPS & STP Design/Sizing Criteria and Other Requirements".

5.5 Treatment Process

The main treatment process train for TSPS and STP shall consist of the major unit processes and components listed in Paragraph 5.16. This list shall not be considered as a comprehensive description. The Contractor shall provide a complete, fully functional facility designed for proper, easy operation and to meet the stated performance requirements. This shall include any and all additional, ancillary, supporting, or other processes, components, equipment, or other items necessary to achieve these objectives, regardless of whether such items are explicitly listed in this Bidding Document or not.

The design/sizing criteria, minimum number of units, and other requirements for the various unit processes and components are listed in Paragraph 5.16and Part 11.

5.6 Demolition or Interfaces and Tie-Ins with Existing Facilities

All existing facilities that are to be demolished shall be properly decommissioned, removed, and appropriately disposed-off by the Contractor in accordance with all applicable laws, regulations, and

standards. Items, components, or materials, whether buried, exposed, submerged, or otherwise, shall not be abandoned or left on site unless explicitly indicated in the Bidding Document. For facilities that are to be eventually demolished but must remain in service until alternate or replacement facilities are constructed and commissioned, whether under this Contract or a different Contract, the Contractor shall ensure that the facilities are protected and remain functional until such time as the alternate or replacement facilities are constructed, tested, commissioned, and accepted by Employer.

All existing facilities that must remain in service permanently shall be protected by the Contractor such that they remain fully functional, operable, and serviceable throughout construction, testing, and commissioning of the new facilities. The Contractor shall be fully responsible for installation and, if necessary, ultimate removal of any temporary facilities or connections (piping, utilities, power, controls, etc.) that may be necessary to maintain existing facilities fully operational throughout construction and commissioning. Temporary or permanent interfaces between existing and new facilities may involve making connections or "tie-ins" to existing live structures, piping, wiring, cabling, equipment or other components. The Contractor shall be fully responsible for detailed design, planning, and implementation of such interfaces in a safe and secure manner.

5.7 Modular Design, Construction, and Operation for Reliability, Redundancy, Turndown, and Easy Future Expansion

The initial design capacity and the ultimate build out design capacity required are both specified in Paragraphs 5.1 for each TSPS & STP. This paragraph shall be read in conjunction with other relevant paragraphs and parts of the Bidding Documents.

For TSPS, components that can be expanded in the future, the design and construction of the initial design capacity under this contract shall be performed such that future expansion to the ultimate build out capacity can be accomplished easily and in a modular manner while maintaining the initial capacity fully operational at all times.The Contractor's submittals and drawings shall clearly show and describe the future expansion and how the future works can be accommodated within the constructed facilities of Site.

For all components under this Contract, the capacity to be provided shall be designed and constructed using multiple, suitably sized unit process modules to ensure reliability, redundancy, and appropriate turndown for optimum capacity utilization and process efficiency. The minimum number of working and standby modules or units required for each component shall be as listed in Paragraph 5.16and Part 11 of the Bidding Documents.

5.8 Design of Plant Layout

The TSPS and STP components shall be laid out and fully contained within the respective designated site boundaries so as to logically interface with the sewers and/or pumping mains that are to be connected to the TSPS/STP to be constructed under this Contract and all existing infrastructure that may be present at the sites and that must remain in service, if and as appropriate.

The layouts shall be planned and designed, such as to optimize the connections between the (i) the inlet(s) to the TSPS and the sewers which are to be constructed under this Contract, but under different Conditions of Contract and (ii) inlet(s) to the TSPS and the pumping mains/sewers and the sewers which are to be constructed under this Contract, But under different Conditions of Contract, as mentioned above.

The Contractor's proposed site layout for TSPS and STP shall clearly show the space allocated for the plant components, including those components and/or unit processes that are designated for future construction or installation. Setbacks and clearances from the site boundary shall be provided as appropriate and as required by law.

All existing utilities (including water, sewer, power, or others, whether overhead or underground and whether physically located on the site or not) requiring to be relocated to accommodate the Contractor's proposed and approved site layout shall be relocated by the Contractor at no additional cost and without interrupting provision of such utility services to users and customers. Such relocations shall be fully coordinated with the Employer.

The plant layout shall adhere to the following minimumrequirements, regardless of whether or not such requirements or any related components are shown in any drawings or specifically listed or described in any part of the document included in the Contract Document.

- Minimum clear distance provided to permit safe and convenient access for operation and maintenance shall be 3m between adjacent treatment units or fixed structures and 1.2m between pieces of equipment.
- Minimum clear distance of 1.2m shall be provided between two adjacent screen channels to permit safe and convenient access for operation and maintenance.
- Access and maintenance laydown area shall be provided adjacent to all mechanical equipment.
- All electrical equipment (except for motors) shall be located above the high flood level elevation for the site or for the effluent receiving water body, whichever is higher.
- All process units / storage tanks shall be labeled with name, sizes and volume. Letters shall be of a size suitable for the application but shall not be less than 120mm high. Labels shall be located at 90-degree intervals at a suitable elevation.
- plant items for mechanical, electrical and instrumentation shall be fitted with a unique name plate bearing the individual plant reference name for the plant item.
- Contractor shall generate master asset database of the plant (TSPS and STP) under this contract and should update same during O&M period. Further, all assets shall be labeled with unique asset number with quick response (QR) code which shall be linked to master asset database of plant and shall provide all details of asset when scan the QR code.
- Access facilities shall be provided for People with Disabilities; at minimum for all the locations at Finished Ground Level and Finished Floor Level.
- Contractor shall provide bird eye view of entire plant by constructing viewing area above admin building. Further, contractor shall ensure that stairs of admin building shall terminate at bird eye view area.
- Minimum 1500mm wide continuous walkway shall be provided for walkthrough of liquid stream process units which shall start at Inlet Chamber of TSPS/STP and end at Chlorine contact tank outlet channel and there after sludge stream units terminating at PLC/SCADA room. Crossing of this walkway with plant internal road shall be painted as "WALKWAY".
- Minimum 1200mm clear width of platform shall be provided to all process units like TSPS, Inlet works, SBRworks,Disc filters, CCT, sludge sumps and any other location as required to meet the access requirement as specified in tender.

- Vehicular access shall be provided for the plant structures and buildings. A pedestrian access door shall be provided adjacent to each vehicle access door in a building. Vehicular routes within buildings shall be clearly marked and process equipment, pipes, cables etc. shall not be located within one(1) meter of a marked vehicular route; appropriate physical protection shall be provided for equipment, pipes, cables etc. located close to a vehicle access route to minimize the risk of damage.
- All process buildings including electrical and pumping stations shall be provided with access doors on all four sides of the walls to enable exit during emergency.
- Theplant internal roads and plant approach road shall be of asphalt macadam and minimum width shall be as specified in tender document.
- All the roads shall be provided with minimum Curb radius of 3.5m unless specified otherwise.
- All roads shall be provided with storm drain on either side of road or single side based on drainage flow pattern and shall be constructed to prevent standing water.
- All the roads shall be provided with painted concrete curb stone on both side of road with minimum concrete curb stone height as 300mm.
- Minimum 750mm of paved walkway shall be provided on either side of road which shall be 300mm above the road surface. Contractor shall propose storm drain below this walkway.
- Contractor shall ensure that the plant internal roads shall be provided with 100mm edge line marking,this shall be marked at 300mm away from curb stone on both sides of road with industrial grade paint.
- Proper drainage of the area around all the buildings shall be provided to avoid stagnation of rain water to prevent malarial conditions.
- Contractor shall appoint dedicated Architectural Engineer for developing Architectural view of complete plant, further contractor shall ensure that architectural view of all process and non-process building shall reflect the current era architecture as approved by Engineer.
- Contractor shall appoint dedicated Landscaping Engineer for developing Landscape layout of complete plant, further contractor shall ensue that landscaping view of complete plant should be pleasant and shall reflect modern landscaping practice of current era.
- Plantation & horticultural activities of landscaped area shall be properly maintained to give pleasant environment of build out campus throughout the O&M period.
- The speed limit for all vehicles within plant boundary shall be not more than 15kmph and same shall be displayed at suitable locations within plant road, at least at road intersection. Further, all the road intersection within plant shall be provided with direction boards at suitable elevation as directed by Engineer.
- Display hoarding for safety signs at suitable elevation shall be provided both indoors and outdoors. These safety signs shall cover mandatory, prohibition, warning, emergency, fire-fighting and general notices as directed by Engineer.
- Display hoarding of painted plant layout shall be placed outside the admin building and near the main entrance gate at suitable elevation as directed by Engineer.
- A digital display board of size 1200mm x 900mm height shall be placed near the main entrance gate to digitally display both inlet and outlet parameters of the STP.
- A Scale model of all the facilities within the plant boundary shall be displayed inside theAdmin building with brief description of each unit process. Model shall be kept inside the glass box

having dimensions 2.4m Length x 1.8m Width x 0.45m Height. The Model shall be placed at suitable height above the Finished Floor Level as directed by Engineer.

5.9 Design Requirements

The following design requirements shall be meant for the, TSPS, STP and Pumping Mains. These requirements shall be fully met regardless of whether or not such requirements or any related components are shown in any drawings and other documents included in the Contract Document.

- The Contractor shall perform a complete Hazardous Area Classification analysis as per IS 5572 for the TSPS, and STP in this contract and shall submit a complete report of such analysis as well as Hazardous Area Classification Drawings that delineate boundaries of all classified areas and indicate the classification of each area. All electrical or other powered equipment, instrumentation, or components shall fully comply with all requirements of IS 5571.
- All components (including but not limited to equipment such as pumps, blowers, screens, diffusers, inline devices; instruments such as flow meters; and distribution and collection channels or pipes) shall be provided with appropriate isolation devices such as valves, gates, or other devices in order to allow isolation, drainage, cleaning, calibration, servicing, and maintenance of such components.
- Bypasses shall be provided around all flow meters and other in-line instrumentation such that the instrument can be isolated and removed for calibration and maintenance without interrupting the flow, regardless of whether or not such bypasses are shown in any drawings included in the Contract Document.
- All equipment, where necessary, shall be provided with acoustic, sound-dampening enclosures to limit ambient noise during normal operations (When all working equipment's are in operation) to the limits as detailed in Part 14.
- Particularly for blowers, minimum 100mm thick acoustic enclosure shall be provided to limit ambient noise during normal operations (When all working blowers are in operation) to the limits as detailed in Part 14.
- Suction air filters provided for process air blower shall capable of supply the process air that should not contain more than 0.02 mg of dust per $m^3$of process air.
- Cooling arrangement shall be provided to ensure process air temperature of less than 60°C at outlet of each air blower discharge.
- Contractor shall provide back flow prevention mechanisminside the each diffuser to prevent intrusion of liquid and/or solids into the diffuser and air piping under normal operating conditions of aeration system.
- 'H' type retrievable diffuser arrangement (maximum 8 diffusers only of each less than or equal to 1m in length) with Fully EOT crane (LT, CT, Lift) (3 drives) with rail arrangement for each basin for lifting and lowering the diffusers during maintenance. Refer 5.16 and Part 11 for type diffuser arrangement.
- All equipment shall be arranged, and buildings and structures designed to permit safe and easy access to and removal of all equipment.
- Fixed runways, lifting eyes, cranes, hoists, or other appropriate devices and means shall be provided to permit safe and easy removal of all equipment for maintenance or any other purpose.

- Minimum 1.5 factor of safety shall be incorporated over maximum weight to lift while selecting the capacity of any type of lifting device.
- All structures, whether liquid-holding or not, shall be designed such that they can be fully and completely drained and will not float or move when empty, because of groundwater buoyancy or any other reason. The structures shall be designed to counteract any possible floatation without the use of any type of groundwater pressure relief valves, including during construction.
- The floors of all liquid-holding structures shall be appropriately sloped and trenches and drain sumps shall be provided at the bottoms of such slopes to facilitate complete drainage of liquid. Appropriate drain pipes and valves connected to the drain sump(s) shall be provided for all structures. Where the drain pipe connects to the structure, the top-of-pipe elevation shall be at least 150 mm lower than the lowest floor elevation for the structure. The drain piping shall be routed from the structure being drained to the Plant Drain Pump Station. For liquid-holding structures, the drain piping and fittings shall be sized such that the entire structure can be drained by gravity in no more than eight (8) hours. The Plant Drain Pumping Station, Plant Drain Pumps, and other related equipment and controls shall be designed and sized to allow draining of the structure with the largest volume from full to empty within eight (8) hours. The highest design water level (High-High Alarm) in the Plant Drain Pumping Station wet well shall be at least 300 mm lower than the lowest pipe invert elevation amongst all drain pipes connecting to the wet well.
- Non-liquid-holding areas, structures, or buildings where leakage or other wet activities can occur, whether in normal use or during maintenance, shall be provided with covered drainage channels which shall direct the spillage either to a suitable gravity drain or to a sump equipped with standard dual submersible sump pumps discharging to the Plant Drain Pump Station.
- All flow meters including its isolation, bypass and drain valves shall be placed in valve chamber with proper access and drain arrangement. No flow meter shall be allowed to install vertical in direction. Also, valves shall have extended spindle and chamber shall be covered with aluminum chequered plate of 6mm thickness. Height of the flow meter chamber shall be minimum 500mm above the FGL and floor level of chamber shall be minimum 300mm from bottom of pipe flange.
- TSPS, sludge sumps, plant drain sump and scum sump shall be covered with RCC slab with access manholes and air ventilation system.
- All air vent pipes shall be extended to minimum 900mm above the parapet wall of the building with mesh cowl on top of pipe. MOC of air vent pipe shall be of Ductile Iron with minimum diameter of 150mm.
- All buried pipe shall have socket and spigot joint. Incase flanged connection is considered for buried pipe then an appropriate flange protectors shall be provided for each flange joint.
- Interceptor and containment bunds shall be provided for containment of all chemicals, fuel and wash water as a resultant from spillages and overflows. The Contractor shall take due regard to the potential of hazardous mixing of chemicals, particularly as a result of leaks and spillages, and their drainage and containment.
- All chemical storage floor area shall be raised minimum 300mm above the FFL and shall be provided with acid resistance tiles with minimum height of 2.1m including its floor.
- All concrete structures in contact with sewage and/or sludge shall be provided with full interiorcorrosion protection linings and/or coatings (Including its floor area and all side walls);this

shall applies to all concrete structures in contact with any type of sewage and/or sludge anywhere in the plant including but not limited to complete works of TSPS, Inlet works, Anaerobic zone, Anoxic zone, Aerobic zone, Sludge storage tanks, Channels etc.,

- Complete chlorine contact tank including its free board and its inlet & outlet channel and outfall structure shall be provided with White/Sky Blue porcelain - like finish (tiles) free from any pits or recesses to avoid accumulation of bacteria and dirt, else which might hinder to achieve desired outlet fecal coli-form.
- All channels carrying process liquid shall be fully covered with solid non-skid GRP/FRP cover access manholes (not grating) designed for human traffic live loads at a minimum and heavy vehicle live load wherever the channel crosses traffic paths.
- Inlets into tanks, reactors, or other structures via pipes, channels, valves, or gates shall be designed such that the incoming flow does not cause any damage or excessive wear whatsoever to the structure (including corrosion protection linings and/or coatings) or any equipment in the vicinity under any hydraulic condition, including but not limited to the condition when the structure is empty.
- Walkways, flooring, hand railing, Plant, etc. shall be designed to take account of the prevailing conditions and be of corrosion-resistant materials. The Contractor's attention is drawn in particular to areas including, but not limited to TSPS, and Inlet Works.
- All walkways and staircase shall be provided with non-skid floor tiles of industrial grade designed for human traffic live loads and equipment load that carried on walkway. Whereas all the admin building requirements including staircase, flooring etc., shall be as specified elsewhere in this Bidding Document.
- Dedicated working area shall be provided on SBR tank for proper access, lifting and maintenance of installed mixers, valves, flow meters and pumps.
- Apart from dedicated lay-down area for diffusers which shall be provided near the SBR tanks, contractor shall also provide dedicated working area on SBR tank for proper lifting, maintenance and reinstallationof retrievable diffusers. For this, contractor shall provide minimum 2400mm clear width of operating platform for SBR tanks with retrievable diffusers arrangement.
- flooring of blower room and all type of pump house buildings shall be non-skid in nature and shall be designed to allow for Plant to be removed and stored on the flooring where required for maintenance, in accordance with the Tender requirements and as per good engineering practice.
- Platforms, handrails/guardrails, ladders, stairs and safety chains shall be provided for proper, safe, and easy access to and/or operation of valves, gates, instruments, control panels, and other devices, equipment, or structures, as well as removal of the above items. All platforms and handrails shall be provided with toe guards of minimum 100mm width.
- RCC staircases with handrail shall be provided to all treatment plant units, flow dividing chambers and other structures to connect to the elevated RCC walkway platforms for which the height of the floor above/below finished ground level exceeds 300mm or that in the prevailing standard.
- The minimum straight suction length for non-submersible pumps viz. Horizontal/Vertical Centrifugal solid handling dry pit pumps, horizontal centrifugal pumps, Progressing cavity pumps, diaphragm/metering pumps shall be 1.2m or five times the diameter of suction pipe whichever is high.

- All piping shall be of corrosion–resistant material appropriate for the service and shall be provided with interior lining, exterior coating, and other corrosion protection as appropriate and necessary to meet the requirements for design life.
- All piping shall be fully and adequately supported and braced to comply with all applicable codes and standards. All supporting hardware shall also be of corrosion-resistant material. The design of pipe supports, and anchors shall fully account for static and dynamic vertical, lateral, longitudinal, and seismic loads, fluid flow, and thermal expansion. Seismic bracing thrust restraints and/or thrust blocks, and appropriate expansion joints or loops shall be provided as needed. Pipe lengths and joints shall be assembled and arranged for ease of removal in such a way that individual runs can be changed without dismantling adjacent pipes, by providing dismantling joints at regular intervals.
- All mixed liquor and sludge lines shall be provided with appropriate cleanouts and flushing arrangements for safe and easy flushing using high-pressure water of minimum 3.5kg/cm2.
- All liquid service pipes shall be provided with appropriate means for safe and easy drainage of the pipes when not in service.
- All pipelines shall be color banded and suitably labeled with the stream designation and direction of flow to enable individual lines to be identified throughout their run. Particular attention shall be paid to the painting of each chemical line, which shallbe based on type of chemical flowing in pipe.
- Particular attention shall be paid to the layout of the chemical piping, which shall be arranged without clutter and shall be functional and neat in appearance. Generally, where piping is installed in ducts, it shall be supported not less than 250 mm clear of the floor.
- All piping routed under any type of structure or equipment shall be fully and completely encased in reinforced cement concrete, with the encasement thickness beyond the outer diameter of the pipe being at least 200 mm on all sides. The encasement shall extend along the pipe length for a minimum horizontal distance of 1500 mm in each direction beyond the footprint of the overlying structure or equipment.
- All piping connecting to, entering, or exiting any and all structures shall be provided with appropriate restrained flexible connections and/or joints at all such interfaces with structures to allow for differential movement between pipe and structure in all directions without stressing or breaking the pipes.
- Appropriate restrained flexible connections and/or joints shall be provided for all pipes where they connect to any and all of the following:
    - Equipment such as pumps, blowers, or inline devices
    - Valves
    - Wall, floor, or roof penetrations
- Maximum length of the puddle pipe shall be of 300mm on either side of the wall thickness.
- Where piping or other materials susceptible to damage from direct sunlight/ultraviolet radiation, they shall be protected from such light/radiation through the use of appropriate additives and/or coatings and shall be physically shielded from direct sunlight/ultraviolet radiation at all times (including prior to and during installation) in their normal service location using enclosures, covers, canopies, roofs, and/or other similar means.

- During cleaning cycle of centrifuge, no spillage or washed flows of centrifuge shall fall on the floor of sludge loading area from sludge hopper; design of centrifuge piping arrangement and sludge hopper shall be done (pneumatic operated cut gate) such that all washed flows of centrifuge shall pass through centrate line of centrifuge.
- RCC mezzanine floor shall be provided for sludge conveyor area of centrifuge with staircase access.
- High pressure water jet spray shall be provided to clean the accumulated screening material from both mechanical coarse screen and fine screens to ensure smooth operation while resume from standby to working condition and vice versa.
- Appropriate sampling ports and/or sampling valves shall be provided to allow easy, safe sampling of all process streams without spillage or contamination and without the need to interrupt normal operation.
- Foam, scum, fats, oil, grease, or any other floating material removed from any location in the STP shall be completely removed from the process flow path and under no circumstances returned / recycled to any location in the plant.
- All spare requirements specified for diffuser membrane, disc filter cloth, mixers and other spare parts of electromechanical equipment's shall be instantaneous. (i.e., equal amount of used spare shall be replaced with new spares to maintain the minimum spare quantity specified in bidding document) throughout the O&M period.
- While selecting any type of pump and blower, priority shall be given to higher pump/blower efficiency and lower power consumption and shall ensure that pump/blower can operate at high efficiency throughout its service life. At minimum contractor shall ensure efficiencies of pump/blower as listed below:
    - Minimum efficiency of all types of Submersible Pumps shall be 60%
    - Minimum efficiency of Centrifugal Turbo blower shall be 90%
- The Works shall be designed and operated and maintained to minimize odours within, at the boundary of and in the vicinity of the Sites. The layouts of the Works shall take account of the prevailing wind direction and speed at different times of the year. Mature trees shall be provided around the full boundary of all sites, except for at accesses to the sites.
- For air flow isolation and control butterfly valves shall be provided for all pipe sizes.
- Common wall between the compartmentsof TSPS shall be raised 900mm above the crown level of the highest incoming sewer to inlet chamber.
- All process and non-process buildings including pumping stations shall be provided with wall mounted digital displayof temperature and noise level of the respective buildings and same shall be connected through plant SCADA for remote monitoring/display. Local parameter display shall be with digital screen of size 10inches.
- Contactor shall ensure that all necessary provisions and features are incorporated in all electrical designs and installation to monitor process specific energy consumption. Such energy consumption shall be displayed locally through multi-function energy meter and same shall be connected through plant SCADA for remote monitoring/display. These dedicated facilities shall be provided at minimum of following locations viz., (i) TSPS units, (ii) Preliminary units, (iii) Secondary treatment units (Including blowers), (iv) Disinfection system, (v) Sludge handling system, (vi) other miscellaneous units.

5.10 Hydraulic Design Requirement

A representative layout for TSPS and associated STP are included in Volume 4 of this Bidding Document. These drawings shall be considered representative only. In the event of any conflicts between information in the drawings and Part 5, then Part 5 – "Process Requirements" shall govern in accordance with the Priority of Documents.

Topographical survey information, benchmarks, contour maps, geotechnical/soil investigations, and effluent receiving water body high flood level (HFL) elevations for TSPS and STP sites and sewer and pumping main alignments are included with these Bidding Documents and/or available from the Employer on request. However, the Employer makes no guarantees or representations whatsoever regarding this information. The Contractor's use of this information shall be at his own risk. The Contractor shall independently obtain any and all site information necessary for proper planning, design, construction and operation and maintenance of all Works/components in the Contract.

Contractor shall submit self-explanatory hydraulic design calculations in unlocked editable MS-Excel format and shall ensure that the plant layouts and hydraulic profiles shall comply with the following specific and all other requirements described in the Bidding Document:

- Hydraulic calculation shall be prepared for all flow conditions like minimum, average, maximum and one unit out of service condition and hydraulic flow diagram shall indicate all of these flow levels.
- The Contractor shall provide at the TSPS and STP all necessary facilities for overflow/bypass of the process liquid at various locations in the flow path as indicated below. These facilities are included in this contract and shall be provided regardless of whether or not they are shown in any drawings included in the Bidding/Contract Document. They shall be fully functional in all respects and shall include any and all components necessary to safely and efficiently accomplish the intended overflow/bypass. Each overflow/bypass facility shall include, but not be limited to:
    - Downward opening motorized overflow weir gate installed in the appropriate channel or structure from which the overflow/bypass is to be affected.
    - An appropriately sized buried (above ground piping will not be acceptable) pipe to carry the overflow/bypass from the channel or structure.
    - An appropriately sized flow meter along with all associated components and infrastructure to automatically measure and record details of all overflow/bypass events, including but not limited to date, start time, end time, continuous flow rate data for the entire duration of the event, and a totalized volume for the event, shall be provided.
- At minimum, the following locations at the STP/TSPS shall be provided with overflow/bypass arrangement which shall be sized to handle plants peak flows for respective design period as specified in the tender document:
    - At the TSPS Inlet Chamber upstream of the trash screens to the final outfall structure by gravity.
    - At the STP Downstream of the Grit Chambers and upstream of the Parshall Flume to the final outfall structure by gravity.
- Location of outfall structure to discharge treated sewage shall be as directed by Engineer. However, contractor shall ensue that outfall structure shall be located nearest to the receiving water body and flow shall be discharged with cascade effect.

- All aspects of the design of the hydraulics shall be based on sound principles and good common engineering practice typical for sewage treatment works.
- All process units shall be capable of passing the required peak sewage flows, including returned flows as specified.
- All the flows shall be evenly distributed between the numbers of process units in operation for all flow conditions.
- The hydraulic design calculations shall demonstrate the hydraulic functioning of the STP if any one of the process units were to be out of service for maintenance.
- Hydraulic calculations shall be based on the Hazen-Williams formulae for pipe and the Manning equation for open channel flow.
- For TSPS and STP hydraulics, Hazen-Williams co-efficient of 100 shall be considered for all liquid pipelines for gravity and pumping design.
- For all type of gravity channels, Manning co-efficient of 0.015 shall be considered in design.
- The head loss calculations in all sludge pipe work shall take account of the specific sludge characteristics for different types of sludge including the variations in viscosity arising from changes in the dry solids content and characteristics of the sludge.
- If Contractor's design of sludge line hydraulics is based on Hazen-Williams formula then, Hazen-Williams co-efficient of 60 shall be considered for all sludge piping both for gravity and pumping design.
- The division of flow between the individual treatment units shall be achieved by:
    - Non-submerged (i.e. with a positive free-fall from weir invert to the water surface on the downstream side) overflow weirs followed by isolation gate.
    - Non-submerged downward opening overflow weir gates.
    - All air / sludge flow distribution shall be with automatic feedback flow control using inline flow measurement and modulated flow control valves with actuators and data input and control through PLC/SCADA.
- Sharp crested weirs with free discharge shall be used and shall be designed to include adequate provision for maintaining atmospheric pressures beneath the nappe.
- A positive free-fall of at least 150mm shall be provided to upstream weir crests under peak flow conditions with all streams operational.
- All the flow distribution boxes shall be equipped with adjustable weir plate for equal flow distribution to each side of weir plate. Further, weir followed by isolation gate shall be provided for each weir side of flow distribution box.
- Weir length of flow distribution box shall be designed to give maximum 150mm of head over the weir at peak flow condition.
- SS 316 weir plate with minimum 6mm thick shall be provided on each weir side of flow distribution box and shall be capable to adjust at least 75mm of its height unless specified otherwise.
- For flow distribution box, at least 1.5m of clear liquid height shall be provided between tip of the weir and invert level of flow distribution box, unless specified otherwise.
- Where flow distribution box receives the flow from channel, the connecting point between incoming channel and flow distribution box shall be provided with minimum 600mm of chamfer followed by under flow baffle wall.

- All pipes and channels shall be provided with proper slope based on calculation. Also, shall ensure that provided slopes shall facilitate draining of pipes and channels when required during maintenance.At minimum following slopes shall be considered in design unless specified otherwise:
    - All pipe lines carrying plant drain and scum shall be provided with minimum 1% of slope.
    - All channels carrying liquid shall be provided with calculated slope or minimum 1% of slope
    - All gravity sludge lines shall be provided with minimum 1.25% of slope
    - All below ground pumped sludge lines shall be provided with minimum 0.4% of slope.
    - Gravity flow either liquid or sludge shall not be permitted to flow against the slope.
- Bed level of all channels shall be provided with slope, Slope shall be provided either by constructing the bed level of channel as per calculated slope or by providing screeding in channel. If channel is provided with screeding to achieve slope, then a minimum 50mm thick screeding shall be considered at lowest discharge point of channel and accordingly calculated slope shall be provided to upstream side of channel. Contractor shall make a note that flat-bed level of channel without slope isnot accepted.
- All corners of channel in contact with liquid shall be provided with fillet having minimum radius of 150mm. Further, change in flow path/direction of channel shall be achieved with smooth curve to avoid turbulence in flow.
- All corners of SBR basin in contact with liquid shall be provided with fillet having minimum radius of 600mm.
- All side corners in contact with liquid in chlorine contact tank shall be provided with fillet having minimum radius as specified in paragraph 5.16. Whereas for other corners of chlorine contact tank in contact with liquid shall be provided with fillet having minimum radius of 300mm.
- All corners in contact with liquid in sludge storage tank/sump and any other storage tank/sump shall be provided with fillet having minimum radius of 450mm.
- The termination end of all the baffle walls proposed in CCT shall be provided with semicircular end.
- Contractor tocarryout CFD analysis and results of same shall be incorporated in General arrangement drawings of following process units at minimum:
    - Complete TSPS
    - STP Inlet Chamber with Fine Screens
    - SBR Tanks
- All below water RCC columns proposed in SBR tank or any other process unit shall be circular in shape.
- For all structures containing water or process liquid, the minimum freeboard (distance by which top of wall / bottom of slab in case of walkway or closed tank is higher than the maximum water surface level at receiving water under one unit out of service condition for all flow condition shall be 0.5m unless specified otherwise.
- All the 90 degree bends of the pipe carrying the flows of sludge and air shall be of long radius with minimum 1.5 times the its pipe diameter.
- All pumps shall have flooded suction and negative suction shall not be allowed in pump selection.

- Maximum pipe flow velocity shall be no more than 1.0 m/s for all gravity flow and pump suction lines unless specified otherwise.
- Maximum pipe flow velocity shall be no more than 1.5 m/s for all pumped discharge linesunless specified otherwise.
- Calculated normal velocity (at 20°C and 1atm) of air piping shall be not be more than 16 m/s.
- For channels, the maximum velocity shall be no more than 1.0m/s.
- For liquids the maximum velocity through gate opening shall be no more than 0.8m/s unless specified otherwise.
- The size of magnetic flow meter shall be same as that of pipe diameter unless specified otherwise.
- The minimum elevation difference between High water & High-High water level and Low water & low-low water level shall be at least 300mm.
- Minimum 3m of residual head shall be added to the calculated head for pumps.

5.11 Plant Water System

The entire plant water requirement shall be taken from treated water storage tank and shall be used for multiple applications including but not limited to all chemical solution preparation, motive water system, filter backwash system, thickener dilution water (As applicable refer Paragraph 5.16), general cleaning and flushing needs also for landscaping requirements. Further, plant water shall meet "Non-DetectableFecal Coli-form" standards wherever it has possibility of direct or indirect human contact.

A separate overhead tank shall be provided for plant water system. A pressurized plant water booster system shall be provided to supply plant water to all of the selected applications through pressurized plant water ring main. Plant water booster system shall be designed to maintain a minimum pressure of 4.0 bar at the furthest point on the ring main from the booster set under conditions of maximum plant water in use. Pressure gauges complete with isolation valves shall be provided and fitted to all delivery lines and booster set pressure vessels.

The plant water ring main shall have hose connection hydrants as required for cleaning of principal process units and equipment. All potential points of spillage shall be provided with hose connection hydrants for washing down within buildings and areas where sludge or liquor spillage will occur. All such hydrants shall be specially identified as "Non-Drinking Water".

5.12 Potable Water System

Potable water shall be provided and used for safety showers, domestic potable needs and laboratory needs. Separate booster set to supply potable water to a potable water ring main shall be provided. Potable water shall be drawn, via a break tank of capacity 7000Litres, from the main feed to the Site as directed by Engineer. The break tank shall be fitted with the potable water booster set. The potable water booster system shall be designed to maintain a minimum pressure of 1.2bar at the furthest point from the booster set on the potable water ring main under conditions of maximum water use. Alternatively, potable water from break tank shall be pumped overhead tank (Two numbers of each 1000litres) located above admin building designed to maintain a minimum pressure of 1.2 bar at the furthest point from the tank location on the potable water ring main under conditions of maximum water use.

5.13 Process and Facilities Description

This Process and Facilities description is intended to provide the processes and types of facilities that the Contractor shall be required to design, construct, and operate, and apply to all TSPS, STP in this Contract unless specifically indicated otherwise. The Contractor shall use this description together with other specific information for each TSPS, STP provided elsewhere in this Bidding Document, including but not limited to Paragraph 5.16, Part 11, & Volume 4 – "Drawings", all of which are integral to this Process and Facilities Description and are incorporated herein by reference. Contractor shall strictly comply with the specified treatment concept, treatment unit processes, flow configuration (connectivity between unit processes and facilities), performance requirements (such as effluent and sludge quality and equipment efficiencies), and design criteria (such as design operating conditions, various process loading rates and/or detention times, requirements for units out of operation, volumes, and dimensions where specified) such as the minimum requirements specified in the paragraph5.16 and Complete operation of the equipment at TSPS, and STP shall be as defined in control philosophy.

5.14.1 Inlet Manholes to TSPS

TSPS included in this contract that receives raw sewage by gravity directly from one or more BWSSB sewer(s), existing or to be provided under this Contract, Contractor shall be responsible for collecting and conveying the sewage through such sewer(s) to TSPS inlet manhole located within the TSPS/STP boundary, as specified in this Contract Document. Such sewers shall include those to be provided under this Contract.

The Contractor for this Contract shall construct the inlet manholes for TSPS and coordinate the exact location and elevation of such manhole. Contractor shall be responsible for the incoming pipe(s) to the manhole, where there is an existing sewer or a proposed sewer, which directly falls under the responsibility of another organization, for example BDA. However, the Contractor shall be fully responsible for proper coordination to ensure proper alignments and interfaces, and for proper implementation of all connections. If indicated elsewhere in this Bidding Document. However, the Contractor shall be fully responsible for proper coordination to ensure proper alignments and interfaces, and for proper implementation of all connections.

TSPS included in this Contract that receives sewage included in this Contract, the Contractor shall be fully responsible for the entire scope of work for TSPS as specified in this Contract Document, as well as for all connecting piping, including proper alignment, interfacing, and implementation of all pipe connections at both ends.

5.14.2 TSPS Inlet Chamber

For TSPS incoming sewage shall be conveyed from TSPS inlet manhole and/or collection chamber to the TSPS Inlet chamber via an appropriately sized single gravity pipe. An overflow pipe from TSPS inlet chamber shall be provided to overflow/bypass the sewage to final outfall structure and invert level of such overflow pipe shall be such that it shall not lead to overflow of any manholes on upstream side of incoming sewer line. Flow meter shall be installed on overflow pipe and all flow events shall be reordered through PLC / SCADA.

5.14.3 TSPS Trash and Coarse Screens

Trash Screens followed by Coarse Screens shall be provided in deep concrete channels immediately upstream of the TSPS wet well. An electronically controlled automatic jam removal system shall be provided in addition to the safety devices specified elsewhere in the document. The screenings removed by the screens shall be discharged at the appropriate elevation above ground on to a conveyor. A screw conveyor with compactor positioned above ground level shall convey the screenings through a galvanized steel chute to a truck/tractor-trolley positioned at ground level.

5.14.4 TSPS Wet Well

TSPS shall be of the wet well type with submersible pumps. Coarse-screened sewage from the Coarse Screens shall be collected via appropriately sized channels into a common channel which shall connect to the wet well. Partition requirement of TSPS wet well shall be as indicated in paragraph 5.16

5.14.5 TSPS Pumps

Coarse-screened sewage shall be pumped by the TSPS Pumps to the STP Inlet Chamber as specified in the Bidding Document. Pump operation shall be automatically controlled based on wet well level and as defined in control philosophy.

5.14.6 STP Inlet Chamber

Incoming sewage shall be conveyed from TSPS rising main to the STP Inlet chamber via an appropriately sized single pumping main.

5.14.7 Fine Screens

Fine Screens shall receive coarse-screened sewage from the STP Inlet Chamber. An electronically controlled automatic jam removal system shall be provided in addition to the safety devices specified elsewhere in the Bidding Document. The screenings removed by the screens shall be discharged at the appropriate elevation above ground on to a conveyor. A screw conveyor with compactor positioned above ground level shall convey the screenings through a galvanized steel chute to a truck/tractor-trolley positioned at ground level.

5.14.8 Vortex Grit Chambers, Grit Washers and Classifiers

Acomplete grit removal facility shall be provided. All equipment and components necessary for a fully functional system shall be provided regardless of whether or not such items are specifically listed or described in the Bidding Document. Washed, dewatered grit shall be collected in a truck/tractor-trolley positioned at ground level below the Grit Classifier discharge through a galvanized steel chute. De-gritted sewage shall exit the Grit Basins over the outlet weir. Liquid streams from grit washers and classifiers shall be returned to the de-gritted sewage stream or to the Plant Drain Pumping Station.

5.14.9 Parshall Flume

A prefabricated Parshall flume section of MOC: SS 316 with thickness 6mm (Converging portion, throat portion and diverging portion) shall be installed in RCC channel to ensure smooth flow measurement. Parshall Flume shall be provided after the grit removal system, and flow shall be

measured continuously at the Parshall Flume with an ultrasonic type flow meter suitable for Parshall Flume application. All flow events shall be recorded through PLC / SCADA.

Upstream of Parshall Flume and downstream of Vortex grit chamber, an overflow chamber with motorized downward opening weir gate shall be provided to overflow/bypass the sewage to final outfall and flow meter shall be installed on overflow pipe and all flow events shall be reordered through PLC / SCADA.

5.14.10 SBR Basin Flow Distribution Box

The preliminary treated effluent shall flow by gravity from the Parshall Flume to the SBR Basin flow distribution box from where it shall be distributed equally to each of the SBR basins. Appropriate isolation gates and/or valves shall be provided to allow isolation of each basin.

5.14.11 SBR Basins

Al equipment and components necessary for a fully functional facility shall be provided regardless of whether or not such items are specifically listed or described in the Bidding Document.

5.14.12 Alum Dosing System

An alum dosing system shall be provided for chemical phosphorus removal in the event of inadequate biological removal.

A common set of alum dosing pump shall pump the alum to SBR basin influent channel or other suitable location which meets the Employer's Requirements.

5.14.13 Disc Filters

Acomplete disc filter facility shall be provided in Mangalore tiledroofbuilding with steel strussto filter effluent from SBR. All equipment and components necessary for a fully functional facility shall be provided regardless of whether or not such items are specifically listed or described in the Bidding Document. A bypass shall be provided to the Filters for maintenance or in the event that effluent quality from the SBR is such that the Filters do not need to be used to meet the effluent quality standards.

5.14.14 Chlorine Contact Tank Flow Distribution Box

Flows from the disc filters effluent channel shall flow by gravity to the chlorine contact tank flow distribution box from where it shall be distributed equally to each of the chlorine contact tank. Appropriate isolation gates and/or valves shall be provided to allow isolation of each chlorine contact tank.

5.14.15 Chlorine Contact Tanks

Chlorine Contact Tanks shall be provided for disinfection of treated effluent from the Disc filter effluent channel. Chlorine shall be dosed into the Chlorine Contact Tanks. A Chlorination Building shall be provided to house all chlorination equipment including chlorine cylinders, chlorinators, neutralization pit and all associated equipment complete. Further, an emergency Chlorine Scrubber and all associated systems and controls shall be provided to contain and neutralize any chlorine gas leaks regardless of whether or not such items are specifically listed or described in the Bidding Document.

5.14.16 Final Effluent

Flow from outlet of CCT shall be measured before it discharges to River/Lake/Nallah through proposed outfall structure. All flow events shall be linked to the PLC/SCADA system to allow daily totalized flow and other flow trends.

5.14.17 Sludge Treatment

Sludge dewatering system shall include centrifuge feed pumps, solid bowl decanter centrifuge, complete auto-polymer system, dewatered sludge conveyors, sludge storage/loading hoppers, and truck access and loading facilities. Sizing of the centrifuges and all related equipment shall be based on the operating schedule specified in Paragraph 5.16.

5.14.18 Plant Drain Sump and Pumping Station

APlant drain sump with pumping station shall be provided to collect drain from various process unit within the STP such as solids processing recycles flows, disc filter backwash flows, thickener overflow and other miscellaneous waste flows such as cleaning and wash-down flows generated in the plant, and to pump them back to the STP Inlet Chamber for treatment through the plant.

5.14.19 Scum Pit and Scum Pumping Station

Aplant scum pit with pumping station shall be provided to collect the only filtrate from scum generated from SBR units within the STP and to pump them back to the Centrifuge Feed Sump.

5.14.20 Administration, Laboratory, Maintenance, and Other Related Buildings/Facilities

An administration building with furniture (including SCADA room), a laboratory, a maintenance workshop, a storage facility, a guard house, process & electrical buildingsand all related facilities shall be provided for a fully functional facility of STP as detailed below(minimum requirement):

a) 4 Nos. of 4’ x 2 ½’ table with drawers on both sides (3 on each side)
b) 2 Nos. of 3’ x 2’ table with single side three drawers
c) 10Nos Chairs (approved make)
d) Conference table of 12 sitters.
e) Fire Extinguisher – CO2 type (3 Kg) – 2 sets (min).
f) First Aid

5.14 Flow Measurement

A complete flow measurement facility shall be provided at minimum locations as specified below to measure the flows at minimum 99% accuracy. All equipment and components necessary for a fully functional facility shall be provided for all flow measurement locations regardless of whether or not such items are specifically listed or described in the Bidding Document.

a) Flow measurement of raw sewage pumping main at TSPS locations.
b) Overflow/bypass flow measurement at TSPS inlet chamber.
c) Overflow/bypass flow measurement at Downstream of the Grit Chambers and upstream of the Parshall Flume.
d) RAS flow measurement to each SBR tank.
e) WAS flow measurement from each SBR tank.

f) Process air flow measurement to each SBR Basin and its sub-zones
g) Flow measurement on common alum dosing line
h) Flow measurement on common discharge line from plant drain pumping station
i) Bypass flow measurement for disc filter
j) Flow measurement to delivery side of each centrifuge feed pump
k) Poly dosing flow measurement to each centrifuge
l) Final effluent flow measurement at outlet of CCT

All the above locations (And Parshall flume that shall be providedafter grit chamber) shall be provided with continuous flow measurement. Flow measurement devices shall provide instantaneous and totalized flow records and signals. Flow measurement devices shall be linked to the PLC/SCADA system to allow daily totalized flow and other flow trends to be analyzed, recorded and for control of process as specified in tender document.

Daily and totalized inlet and decanted flow from each SBR tank shall be provided and displayed locally and through SCADA. Such flow measurement may be achieved through level transmitter installed in each SBR tank for inlet flow and through time based decanter movement for decanting flow from each SBR tank.

5.15 Sampling/Analysis Locations and Frequencies

Sampling and analysis shall be performed to measure the parameters indicated in the table below, at the locations and frequencies indicated in the table. In case of multiple units (such as multiple SBR basins), the indicated sampling and analyses shall be performed for each individual module. Further, Contractor shall ensure that all the historical sampling data and analysis results shall be stored in database and made available to Employer till end of contractor's O&M period.

Parameter	Frequency	Measurement / Sampling Method	Points/Locations
pH	Continuous	Online	1) Raw Sewage at TSPS 2) Sewage at D/S of Parshall Flume 3) Final Effluent
	Daily	Grab sample	1) Anaerobic Phase 2) Anoxic Phase 3) Aerobic Phase 4) plant overflow/bypass 5) Sludge cake from centrifuge
COD	Daily	Flow-weighted 24-hours composite sample	1) Raw Sewage at TSPS 2) Sewage at D/S of Parshall flume 3) Final Effluent
		Grab sample	1) plant overflow/bypass flows
	Continuous	Online	1) Raw Sewage at TSPS 2) Final Effluent
rbCOD	Daily	Flow-weighted 24-hours composite sample	1) Raw Sewage 2) Sewage at D/S of Parshall flume

Parameter	Frequency	Measurement / Sampling Method	Points/Locations
TSS	Daily	Flow-weighted 24-hours composite sample	1) Raw Sewage at TSPS 2) Sewage at D/S of Parshall flume 3) Final Effluent
		Grab sample	1) plant overflow/bypass flows 2) Waste Activated Sludge (WAS) 3) Sludge feed to Centrifuge 4) Sludge cake from centrifuge 5) Plant Drain Flows
	Continuous	Online	1) Raw Sewage at TSPS 2) Final Effluent
VSS	Daily	Flow-weighted 24-hours composite sample	1) Raw Sewage at TSPS 2) Sewage at D/S of Parshall flume 3) Final Effluent
		Grab sample	1) plant overflow/bypass flows 2) Waste Activated Sludge (WAS) 3) Sludge feed to Centrifuge 4) Sludge cake from centrifuge 5) Plant Drain Flows
Chlorine	Daily	Grab sample	1) plant overflow/bypass flows 2) Final Effluent 3) Plant Water
	Continuous	Online	1) CCT Inlet 2) CCT Outlet
Turbidity	Continuous	Online	1) U/S of Disc Filter 2) D/S of Disc Filter
ORP	Continuous	Online	1) SBR Anaerobic Phase 2) SBR Anoxic Phase 3) Chlorine Contact Tank
BOD_5at 20°C	Daily	Flow-weighted 24-hours composite sample	1) Raw Sewage at TSPS 2) Sewage at D/S of Parshall flume 3) Final Effluent
		Grab sample	1) plant overflow/bypass flows 2) Sludge cake from centrifuge 3) Plant Drain Flows
	Continuous	Online	1) Raw Sewage at TSPS 2) Final Effluent
TKN	Daily	Flow-weighted 24-hours composite sample	1) Raw Sewage at TSPS 2) Sewage at D/S of Parshall flume

Parameter	Frequency	Measurement / Sampling Method	Points/Locations
			3) Final Effluent
	Continuous	Online	1) Raw Sewage at TSPS
Ammonia-N	Daily	Flow-weighted 24-hours composite sample	1) Raw Sewage at TSPS 2) Sewage at D/S of Parshall flume 3) Final Effluent
		Grab sample	1) plant overflow/bypass flows 2) Anaerobic Phase 3) Anoxic Phase 4) Aerobic Phase
	Continuous	Online	1) Raw Sewage at TSPS 2) Final Effluent
Nitrate-N	Daily	Flow-weighted 24-hours composite sample	1) Sewage at D/S of Parshall flume 2) Final Effluent
		Grab sample	1) plant overflow/bypass flows 2) Anaerobic Phase 3) Anoxic Phase 4) Aerobic Phase
Total Nitrogen	Daily	Flow-weighted 24-hours composite sample	1) Final Effluent
		Grab sample	1) plant overflow/bypass flows 2) Sludge cake from centrifuge
	Continuous	Online	1) Final Effluent
Alkalinity	Daily	Flow-weighted 24-hours composite sample	1) Raw Sewage at TSPS 2) Sewage at D/S of Parshall flume 3) Final Effluent
		Grab sample	1) plant overflow/bypass flows 2) Anaerobic Phase 3) Anoxic Phase 4) Aerobic Phase
Total Phosphorus	Daily	Flow-weighted 24-hours composite sample	1) Raw Sewage at TSPS 2) Sewage at D/S of Parshall flume 3) Final Effluent
		Grab sample	1) plant overflow/bypass flows 2) Anaerobic Phase 3) Aerobic Phase 4) Sludge cake from centrifuge
	Continuous	Online	2) Raw Sewage at TSPS

Parameter	Frequency	Measurement / Sampling Method	Points/Locations
			3) Final Effluent
Fecal Coli-form	Daily	Flow-weighted 24-hours composite sample	1) Raw Sewage 2) Final Effluent
		Grab sample	1) plant overflow/bypass flows 2) Plant Water
Total Coli-form	Daily	Flow-weighted 24-hours composite sample	1) Raw Sewage 2) Final Effluent
		Grab sample	1) plant overflow/bypass flows 2) Plant Water
VFAs	Daily	Flow-weighted 24-hours composite sample	1) Raw Sewage at TSPS 2) Sewage at D/S of Parshall flume
		Grab sample	1) Anaerobic Phase
MLSS	Daily	Grab sample	2) Anaerobic Phase 3) Anoxic Phase 4) Aerobic Phase
MLVSS	Daily	Grab sample	1) Anaerobic Phase 2) Anoxic Phase 3) Aerobic Phase
Temperature	Daily	Online	1) Raw Sewage at TSPS 2) Sewage at D/S of Parshall flume 3) Anaerobic Phase 4) Anoxic Phase 5) Aerobic Phase 6) Final Effluent
Specific Gravity	Daily	Grab sample	1) Chemicals 2) Sludge
Concentration / Water Content	Daily	Grab sample	1) Chemicals 2) Sludge 3) Grit
Organic Content	Daily	Grab sample	1) Grit
Volume	Daily	Grab sample	1) Chemicals 2) Screenings 3) Grit 4) Dewatered Sludge Cake
Sludge Volume Index	Daily	Grab sample	1) SBR Basin
DO	Daily	Grab sample	1) Raw Sewage at TSPS

Parameter	Frequency	Measurement / Sampling Method	Points/Locations
			2) Sewage at D/S of Parshall flume 3) Final Effluent
	Continuous	Online	1) Anaerobic Phase 2) Anoxic Phase 3) Aerobic Phase
Microscopic Examination	Monthly Once or as needed	Grab sample	1) Raw Sewage at TSPS 2) Anaerobic Phase 3) Anoxic Phase 4) Aerobic Phase 5) Final Effluent
Odour	Weekly	Prevailing Indian Standard as directed by Engineer.	1) TSPS 2) Preliminary Units 3) Sludge Handling Units 4) All Pump House Building
	Monthly		1) Plant Boundary
Noise	Daily	Decibel Meter	1) All process buildings including pump house
	Monthly	Decibel Meter	1) Plant Boundary

All costs associated with the sample collection and lab analysis shall be met by the Contractor. The analysis shall be carried out and shall be performed in strict compliance with appropriate analytical methods published in Indian Standards, or in "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, or as published by the US Environmental Protection Agency.

In addition, the Contractor is required to validate its analysis on effluent samples weekly once from an approved laboratory (by Bureau of India Standards), which is not connected to the Project. The validation sampling shall be randomly taken based on Employer decision and the cost of validation/ analysis shall be borne by the Contractor.

During the entire operation and maintenance period, Employer shall nominate their official/counterparts for the inspection of specific STP(s) on a weekly basis. Employer shall also nominate a qualified person to carryout periodical inspection of the STP(s) and to conduct surprise checks, without prior notice to the Contractor.

Employer shall check the effluent quality of the STP(s) every day and instruct the Contractor to undertake appropriate remedial measures, if the performance of the plant is observed as not satisfactory.

Employer shall engage an approved agency (or Bureau of Indian Standards Certified Laboratory) for assessing the effluent quality, for which the samples shall be jointly collected by the Employer (or Bureau of Indian Standards Certified Laboratory) and the Contractor.

In the event of breakdown of the flow-weighted 24-hours composite sample equipment, sampling shall be undertaken manually in a day at every two-hourinterval and the results shall be weighted according to flow in order to establish the equivalent daily total load.

5.16 TSPS & STP Design/Sizing Criteria and Other Requirements

Contractor shall submit self-explanatorydesign calculations in editable unlocked MS-Excel format for process and hydraulic designs considering the requirementsspecified in Part 5 and elsewhere in this Bidding Document. Further contractor shall also submit simulation Model of process design by using GPS-X / BIOWIN software.

Below Notes are pertaining to design and sizing criteria specified in following tables:

a) All the process unit sizes/volumes specified are minimum.

b) *All the building dimensions (or Area when calculated) specified are minimum; However, Contractor may upsize these dimensions (or Area when calculated) based on design to meet the specified tender requirements.*

c) *Minimum height specified for buildings shall be as measured from Finished Floor Level to bottom of the roof beam of building*

A) STP based on SBR Process

Item/ Parameter/ Description	Units	Requirements
General Information		
STP-Location	-	Anjanapura
Plant Capacity	MLD	10
Flow Condition to be considered for Design of TSPS		
Design Average Flow	MLD	10
Peak Factor	-	2.25
Design Peak Flow	m3/h	937.50
Flow Condition to be considered for Design STP including TSPS Pumps		
Design Average Flow	MLD	10
Peak Factor	-	2.25
Design Peak Flow	m3/h	937.50
Recycle flow rate	-	Shall be included in design as per flow and mass balance and pumped back to U/S of Vortex grit chamber
Influent Wastewater Characteristics		
pH	-	6.5-7.5
BOD	mg/L	350
COD	mg/L	800
TSS	mg/L	450
VSS	mg/L	360
TKN	mg/L	70
NH4-N	mg/L	45
Total Phosphorus	mg/L	7
Alkalinity	mg/L as CaCO3	370

Item/ Parameter/ Description	Units	Requirements
Min. Ambient Temperature	°C	15
Max. Ambient Temperature	°C	45
Treated Effluent Quality Requirements		
pH - Instantaneous range	-	6.5-8.0
BOD5 at 20°C - Maximum monthly average	mg/L	10
COD - Maximum monthly average	mg/L	50
TSS - Maximum monthly average	mg/L	10
TN - Maximum monthly average	mg/L	10
Alkalinity - Minimum instantaneous	mg/L as CaCO3	70
Total Phosphorus - Maximum monthly average	mg/L	1
Residual Chlorine - Instantaneous	mg/L	0.75
Fecal Coliform - Maximum monthly average	MPN/100 mL	100
Treated Sludge Quality Requirements (Dewatered Sludge)		
Sludge Quality	-	Undigested dewatered sludge
Maximum VSS/TSS Ratio	%	65
Minimum Solid Concentration in Dewatered Sludge	%	20
STP Inlet and Outlet Hydraulic Conditions		
Receiving water body	-	Anjanapura lake
Receiving water body HFL	m	902.00
Finished Ground Level of STP	m	Minimum1.00m above the HFL.
Finished Floor Level of STP	m	0.5m above FGL
Minimum positive free-fall of treated effluent from outfall structure to HFL of receiving water body	m	0.5m above HFL
Lowest Invert level of incoming Gravity Sewer at TSPS inlet chamber	m	6.0 m below the existing road level near the proposed main gates
Minimum drop from lowest invert level of incoming pipe in Inlet chamber of TSPS to downstream high high water level in TSPS Inlet Chamber	m	0.1
Minimum drop from raft level of Coarse Screen Effluent Channel to downstream high high water level in wet well	m	0.3
TSPS		
TSPS Inlet Chamber		
Type	-	Rectangular or Tapered
HRT at Peak flow	s	30.00
Number of units	Nos	1.00
Side Water Depth (Maximum)	m	1.20
Height of Structure above FGL	m	0.75

Item/ Parameter/ Description	Units	Requirements
Trash Screens and Channels		
Screen type	-	J-type Manual Coarse Bar Screen
Velocity through screen openings at peak flow	m/s	0.80
Screening generation rate	m3/mL	0.01
No of Units - Working	Nos	1.00
No of Units - Standby	Nos	1.00
Side Water Depth (Maximum)	m	0.70
Height of Structure above FGL	m	0.75
Screen opening	mm	50.00
Thickness of screen bar	mm	12.00
Bar cross-section	-	Rectangular
Angle of inclination of screen	deg.	90.00
Maximum headloss across screen	mm	200.00
Flow isolation	-	Through isolation gates at U/S. Trash screens and coarse screen are provided in series in a single channel followed by D/S Isolation gate
Height of Structure above FGL (including common wall between channel)	-	0.75
Coarse Screens and Channels		
Screen type	-	Multirake type bar screen with mechanical cleaning and auto jam removal
Velocity through screen openings at peak flow	m/s	0.90
Screening generation rate	m3/mL	0.022
No of Units - Working	Nos	1.00
No of Units - Standby	Nos	1.00
Side Water Depth (Maximum)	m	0.70
Height of Structure above FGL	m	0.75
Screen opening	mm	20.00
Thickness of screen bar	mm	12.00
Bar cross-section	-	Trapezoidal
Angle of inclination of screen	deg.	75.00
Maximum headloss across screen	mm	300.00
Total Length of Trash Screen Channel and Coarse Screen Channel	m	9.00
Flow isolation	-	Through isolation gates at U/S. Trash screens and coarse screen are provided in series in a single channel followed by D/S Isolation gate
Height of Structure above FGL (including common wall between channel)	-	0.75
Coarse Screen Effluent Channel		
Type		Rectangular or Tapered

Item/ Parameter/ Description	Units	Requirements
No of Units	Nos	1.00
Height of Structure above FGL	m	0.75
Minimum length along flow direction	m	1.20
Flow entry to compartment of TSPS wet well	-	With Compartment, Through Individual Isolation Gates.
Height of Structure above FGL	m	0.75
Pumping Station (Wet Well)		
No of wet wells	Nos	1.00
No of Compartments in each wet wells	Nos	2.00
Height of common wall between compartment	-	Common wall between the compartment shall be raised 900mm above the crown level of the highest incoming sewer to inlet chamber
Liquid depth (Operating)	m	2.0
Height of Structure above FGL	m	0.75
Diameter (Minimum)	m	7.00
No of pumps - Working	Nos	2.00
No of pumps - Standby	Nos	2.00
Capacity of each pump	m3/h	470.00
Wet Well Plan	-	TSPS wet well plan area and its shape shall be selected such that it shall accommodate the future installation of pumps valves and its associated piping and its facilities.
Flow isolation and pump configuration in wet well compartment	-	Common isolation gate shall be provided to connect two compartments of wet well such that velocity through isolation gate shall not be more than0.45m/s at peak flow condition, further all pumps including standby shall be equally installed in each compartment
Height of Structure above FGL	m	0.75
STP		
STP Inlet Chamber		
Type	-	Rectangular or Tapered
HRT at peak flow	s	30
Number of units	Nos	1.00
Side Water Depth (Maximum)	m	1.50
Free board	m	0.50
Fine Screens and Channels		
Screen type	-	Multi-rake type bar screen with mechanical cleaning and auto jam removal
Velocity through screen openings at maximum flow	m/s	1.00
Screening generation rate	m3/mL	0.045
No of Units - Working	Nos	1.00

Item/ Parameter/ Description	Units	Requirements
No of Units - Standby	Nos	1.00
Side Water Depth (Maximum)	m	0.8
Free board	m	0.5
Screen opening	mm	6
Thickness of screen bar	mm	10
Bar cross-section	-	Trapezoidal
Angle of inclination of screen	deg.	75
Maximum headloss across screen	mm	300
Minimum Length of Screen Channel	m	6.00
Flow isolation	-	Through isolation gates at both U/S and D/S end of each screen channel
Fine Screen Effluent Channel		
Type	-	Rectangular or Tapered
No of Units	Nos	1
Minimum length along flow direction	m	1.2
Free Board	m	0.5
Vortex Grit Chamber		
Vortex Type	-	Vortex grit mechanism with grit withdrawal (Slurry Pump) System
Sp.gravity of particle	-	2.65
Dia of particle	mm	0.15
Minimum Grit Removal Rate	%	90
Grit generation rate	m3/mL	0.092
Maximum organic content in disposable grit	%	5
No of grit chambers Working	Nos	1
Number of grit chambers Standby	Nos	1
Grit Washers and Classifiers	Nos	2
Flow isolation	-	Through isolation gates at both U/S and D/S end of each grit chamber
Free board	m	0.5
Parshall Flume Channel		
No of Units	Nos	1
Minimum width of approach channel	m	0.8
Free Board	m	0.5
Total length of RCC parshall flume channel (Minimum)	m	15
Prefabricated parshall flume Section	-	MOC: SS 316 with thickness 6mm (Converging portion, throat portion and diverging portion)
Design of Parshall Flume	-	As per IS Code
Secondary Treatment		
SBR		

Item/ Parameter/ Description	Units	Requirements
Process Type	-	SBR Process with Biological Nutrient Removal. (Nitrification, De-nitrification, and Phosphorus Removal)
Design Flow	-	SBR tank design shall include peak flow and recycle flows so as no overflow of tanks at any given time. Refer Part 5, Volume 2 of Tender document for design flows. Further, no part of the free board shall be used to accumulate the excess peak flows in SBR tank.
SBR Flow Distribution		
Inlet flow distribution	-	Through flow distribution box equipped with weir plate for equal flow distribution to each tank. Each weir shall be followed by isolation gate to each tank.
Outlet flow	-	Through Decanter.
Tank Geometry	-	SBR Tank geometry shall be rectangular or square tanks with efficient removal of the scum and shall capable of collecting the scum with varied water levels of SBR tank.
Scum Collection	-	Each SBR tank shall be provided with dedicated Scum skimmer (Helical type / Adjustable weir type / Rotating pipe type) which shall operate to remove surface scum and floatable material from water level at top decanting level, bottom decanting level and average decanting level of SBR tank and pre-zone or selector zone.
SBR Basin Flow Distribution Box		
Number of units	Nos	1
Side Water Depth	m	1.5
Free board	m	0.5
Design Criteria for SBR		
Fill time	Minutes	As per Bidder Design.
Aeration Time	Minutes	As per Bidder Design.
Mixing Time	Minutes	As per Bidder Design.
Settling Time	Minutes	45 to 60
Decanting Time	Minutes	As per Bidder Design.
Sludge Wasting Time	Minutes	As per Bidder Design.
No of Cycles in day	cycles per day	4 or 6 or 8
Minimum No of SBR Tanks - Working	Nos	4
Side water depth (Maximum)	m	6
Free board (Minimum)	m	0.6

Item/ Parameter/ Description	Units	Requirements
SRT	Days	As per Bidder Design.
F/M	-	As per Bidder Design.
MLSS	mg/L	As per Bidder Design.
Maximum MLVSS/MLSS ratio	-	0.65
Volumetric Inlet BOD Loading Rate to SBR Tanks	kg BOD / m^3. d	0.21 to 0.3
Minimum HRT based on average flow	Hrs	28
Sewage temperature for process parameter design	°C	24
SVI	mL/g	120
Pre-Zone or Selector Zone (As Applicable)	-	As per Bidder Design.
Type of mixing (As Applicable)	-	Submersible Mechanical Mixer / Mixing with Air.
Mixing with Air	-	For pre-zone or selector zone mixing, dedicated coarse bubble diffuser shall be provided with dedicated flow measurement to each pre-zone or selector zone. Minimum air mixing rate for mixing with air (at 20°C and 1atm) shall be 0.9 m^3/h.m^3
Submersible Mechanical Mixer	-	Submersible type mixers shall be provided in each SBR basins for SBR design without pre-zone or selector zone. Irrespective of pre-zone or selector zone, if the process cycle includes a fill-mix phase or only mixing phase without aeration, then submersible type mixers shall be provided in each SBR basins for mixing. Minimum unit power input for mechanical submersible mixing shall be 8 to 10W/m^3
RAS Pumps for SBR (As Applicable)		
RAS Ratio based on average inlet flow to SBR tank.	-	The RAS pumps shall be capable of returning flows in the range not narrower than 0.35 to 0.55 times the average inlet flow to each SBR tank.
No of RAS pumps to each tank	--	Each SBR tank shall be provided with dedicated VFD operated (1W+1S) RAS pumps.
WAS Pumps for SBR		
No of WAS pumps to each tank		Each SBR tank shall be provided with dedicated VFD operated (1W+1S) WAS pumps.
Minimum Sludge Generation Fraction @ Inlet BOD load	kg / kg	0.76
Maximum Under flow sludge consistency from SBR tank (For WAS Pump Design)	%	0.80

Item/ Parameter/ Description	Units	Requirements
SBR Decanter		
Decanting Flow at peak flow condition	m3/h	Minimum 1.7 times the average flow.
Lag time	-	Lag time is not allowed for decanting flow. At any given time, minimum one SBR tank shall be under decanting phase.
Maximum decanter weir loading rate	$m^3/h/m$	120
Decanter weir length	m	Shall be calculated by considering 1.7 times the average flow.
No of operating Decanters	Nos	Minimum 1 per each SBR tank.
Maximum Decanting Depth	m	Shall be calculated based on peak flow condition.
Decanter Type	-	Floating or electromechanically positioned with subsurface withdrawal and positive solids and scum exclusion mechanism. Fixed decanters or surface withdrawal not allowed.
Decanter Scum Retention	-	Each decanter shall have in-built scum retention mechanism to prevent surface scum and floatable material from exiting with treated effluent.
MOC of Complete Decanter	-	SS 316L
Process Air Blowers		
Oxygen demand at average flow (AOTR)	kg/d	5702.00
Peak Oxygen Demand Factor	-	1.35
Oxygen demand at peak flow (AOTR)	kg/h	321
Aeration system sizing basis process liquid temperature	°C	27
Minimum DO Level of Aeration basin	mg/L	2
α: Oxygen Transfer Correction Factor	-	0.6
β: Salinity – Surface Tension Correction Factor	-	0.95
F: Fouling Factor	-	0.8
Aeration depth for SOTE calculations	-	Average aeration depth
Design SOTE per m depth of water (Minimum to be provided and maximum to be used as design basis)	% /m	5.5
Blower capacity safety factor	-	1.10
Blower capacity provided at Field Condition (Blower Inlet Temperature 45°C)	m3/h (at Inlet)	6,950
Total number of working blowers	Nos	2
Total number of standby blowers	Nos	1
Blower type	-	Rotary Tri-Lobe with VFD Control
Process Air Diffusers		
Type of Aeration	-	Diffused Aeration

Item/ Parameter/ Description	Units	Requirements
Diffuser type	-	Fine bubble membrane, tubular or disc, fixed type
Membrane material	-	EPDM or silicone elastomer with UV protection
Max air flow per effective area of diffuser for design (at 20°C and 1atm)	$Nm^3/hr/m^2$	70
Min % of uninstalled spare diffusers	%	5
Diffuser Arrangement	-	Diffusers shall be arranged such that aeration shall create a zoning in SBR tank and aeration shall cover complete floor area without dead zones. Each zone shall have a separate air header with isolation valve and flexible air drop pipe with isolation valve.
Blower Building		
Number of Building	Nos	1.00
Length	m	18.00
Width	m	11.00
Height	m	9.00
Scum Pit		
Number of sumps	Nos	1.00
Dia of sump	m	3.00
SWD of Sump (Maximum)	m	1.50
Free Board	m	1.50
Scum Transfer Pumps		
Minimum capacity of each pump	m3/h	5.00
Number of pumps - working	Nos	1.00
Number of pumps - standby	Nos	1.00
Type of Pump	-	Submersible chopper with recirculation valve
Alum Dosing System		
Total No of Dosing Tanks	Nos	2.00
Dia of each tank	m	1.50
SWD of Tank	m	0.90
Free board	m	0.50
Minimum unit power input for mixing	W/m3	300.00
Dosing pump capacity	LPH	100.00
No of working dosing pumps	Nos.	1.00
No of standby dosing pumps	Nos	1.00
Type of Alum dosing pump	-	Hydraulic double diaphragm
Alum Storage Days	Days	30.00
Purity of alum	%	90.00
Concentration of alum solution for dosing	%	10.00
Chemical Building		
Number of Building	Nos	1.00

Item/ Parameter/ Description	Units	Requirements
Length	m	10.00
Width	m	7.00
Height	m	5.50
Alum Mixer		
Min no of units	Nos	1.00
Type	-	In chamber agitator mixing, shall be designed to handle the maximum flow condition
Minimum unit power input for mixing	W/m3	25.00
Disc Filter		
No of Units – Working	Nos	1.00
No of Units – Standby	Nos	-
Minimum flow to each unit	m3/h	710.00
Maximum disc filtration rate	m3/m2/h	12.00
SWD of Filter	m	2.00
Free Board	m	0.50
Inlet TSS after SBR	mg/L	20.00
Design load factor for Inlet TSS to Disc Filters	-	1.50
Outlet TSS from Disc Filter	mg/L	10.00
Type	-	Disc type
Opening size for disc	µm	10.00
No of working backwash pumps	Nos	1.00
No of Standby backwash pumps (Store)	Nos	1.00
Minimum spare media for disc filters	%	5.00
Disc Filters Bypass Channel		
No of Units - Working	Nos	1.00
Width of bypass channel	m	1.20
SWD in channel	m	0.50
Free Board	m	0.50
Disc Filter Effluent Channel		
No of Units	Nos	1.00
Minimum width of channel	m	0.70
Free Board	m	0.50
Chlorine Contact Tank		
Inlet flow distribution	-	Through flow distribution box equipped with weir plate for equal flow distribution to each CCT. Each weir shall be followed by isolation gate to each CCT.
Outlet flow	-	Through overflow weir.
Tank Geometry for CCT	-	Rectangular tank with inlet and outlet channels. Inside configuration of tank shall be such that it shall create the three-pass flow to meet the design condition. Also, all inside

Item/ Parameter/ Description	Units	Requirements
		wetted corners of tank shall be filleted.
Type of Tank Design for CCT	-	Serpentine Design with Long Channels
Minimum HRT for CCT (At Decant flow condition)	Minutes	15.00
Effective L/W ratio	-	40.00
SWD/Pass Width ratio	-	1.00
CCT Flow Distribution Box		
Number of units	Nos	1.00
Side Water Depth	m	1.50
Free board	m	0.50
Chlorine Contact Tank		
No of Units - Working	Nos	2.00
Length of tank	m	18.00
Width of tank (Including 2 Nos of baffle walls with 250mm thickness)	m	4.55
Side water depth	m	1.35
Free Board	m	0.50
No of passes	Nos	3.00
Fillet Radius for Serpentine Design of CCT	m	1.35
CCT Effluent Channel		
No of Units	Nos	1.00
Minimum width of channel	m	1.20
Free Board	m	0.50
Chlorine Dosing System		
Minimum Dose rate	mg/L	5.00
Type of Chlorinator	Type	Vacuum type-Gas Feed
Type of Chlorine Ejector	Type	Inline vacuum induction
Minimum Chlorinator capacity with chlorine ejector	kg/h	5.00
Booster pump capacity	m3/h	5.00
No of working chlorinator with booster pumps	Nos	1.00
No of standby chlorinator with booster pumps	Nos	1.00
No of connected tonners to each chlorinator	Nos	2.00
Total No of tonners	Nos	4.00
Capacity of each filled chlorine tonner	Kgs	900.00
Chlorination Building		
Number of Building	Nos	1.00
Length	m	10.00
Width	m	7.00
Height	m	5.50
Sludge Handling System		

Item/ Parameter/ Description	Units	Requirements
Centrifuge Feed Sump		
Number of Sumps	Nos	1.00
Side water depth (Maximum)	m	3.50
Minimum Volume of Sump	m3	173.60
Free Board (at Maximum water level)	-	0.5
Type of mixing for Centrifuge Feed Sump	-	Mechanical
Mixer Type	-	Submersible
Required unit power input for mixing	W/m3	15.00
Centrifuge Feed Pumps		
Capacity of each centrifuge feed pump	m3/h	28.00
Number of pumps - working	Nos	1.00
Number of pumps - standby	Nos	1.00
Operating Hours for pump	Hrs	12.00
Type of pump	-	Progressing Cavity
Centrifuge		
Capacity of centrifuge	m3/h	28.00
Number of centrifuge-working	Nos	1.00
Number of centrifuge-standby	Nos	1.00
Operating hours for centrifuge (Maximum)	Hrs	12.00
Inlet Sludge Consistency (Maximum)	%	0.80
Outlet sludge consistency from centrifuge (Minimum)	%	20.00
solid capture from centrifuge (Minimum)	%	95.00
Centrifuge type	-	Solid Bowl Decanter Centrifuge
Poly Dosing System		
Number of Polymer System- Working	Nos	1.00
Number of Polymer System- Standby	Nos	1.00
Type of polymer system	-	Auto-polymer system
Volume of each polymer system (Minimum)	Liters	2,300.00
Concentration of solution from polymer system	%	0.10
Type of mixing for polymer	-	Mechanical
Mixer Type	-	Turbine
Minimum unit power input for mixing	W/m3	200.00
Capacity of each dosing pump	LPH	1,150.00
Number of dosing pumps-working	Nos	1.00
Number of dosing pumps-standby	Nos	1.00
Type of poly dosing pump	-	Hydraulic double diaphragm
Feeding point	:	at inlet of centrifuge
Poly Storage		
Bulk Poly Storage	Days	30.00
Minimum Purity	%	95.00
Storage Form	-	White Granules

Item/ Parameter/ Description	Units	Requirements
Centrifuge Feed Pump House		
Number of Building	Nos	1.00
Length	m	8.00
Width	m	7.00
Height	m	5.50
Centrifuge Building		
Number of Building	Nos	1.00
Number of Floors	Nos	G+1
Length	m	8.00
Width	m	7.00
Height of first floor	m	6.50
Height of Second floor	m	5.50
Plant Drain Sump		
Sump	-	-
Number of Sumps	Nos	1.00
Dia of sump	m	3.50
Side water depth (Maximum)	m	2.00
Free Board (at Maximum water level)	m	2.50
Pumps	-	-
Capacity of each pump provided	m3/h	20.00
Number of pumps - working	Nos	1.00
Number of pumps - Standby	Nos	1.00
Electrical Sub-Station (TSPS/STP)		
Number of Building	Nos	1.00
Length	m	12.00
Width	m	10.00
Height	m	5.50
Transformer Yard		
Number of Building	Nos	1.00
Length	m	11.00
Width	m	8.00
Admin Building Includes PLC SCADA, Laboratory		
Number of Building	Nos	1.00
Number of Floors	Nos	G+1
Length	m	10.00
Width	m	10.00
Height	m	4.50
Plant DG Shed		
Number of Building	Nos	1.00
Length	m	10.00
Width	m	8.00
Height	m	5.50

End of Part 5